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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

WAYMO LLC, Plaintiff, v. UBER TECHNOLOGIES, INC., OTTOMOTTO LLC; OTTO TRUCKING LLC, Defendants.	Case No. 3:17-cv-00939-WHA **DECLARATION OF JAMES HASLIM IN SUPPORT OF DEFENDANTS' OPPOSITION TO PLAINTIFF WAYMO LLC'S MOTION FOR PRELIMINARY INJUNCTION** Date: May 3, 2017 Time: 7:30 a.m. Ctrm: 8, 19th Floor Judge: The Honorable William Alsup Trial Date: October 2, 2017

<u>REDACTED VERSION OF DOCUMENT SUBMITTED UNDER SEAL</u>

I, James Haslim, declare as follows:

1. I am a Senior Manager, Engineering for the Advanced Technologies Group at Uber Technologies, Inc. ("Uber") as of January 2017. I understand that Waymo has filed a lawsuit against Uber, Ottomotto LLC ("Otto") and Otto Trucking LLC in the U.S. District Court for the Northern District of California. I submit this declaration in support of Defendants' Opposition to Waymo LLC's ("Waymo") Motion for Preliminary Injunction. I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently.

2. I joined Otto in May 2016 as Senior Mechanical Engineer and LiDAR lead, after Otto completed its acquisition of Tyto LIDAR LLC ("Tyto"). I was tasked with leading the team at Otto in developing a light detecting and ranging (LiDAR) solution for autonomous trucks. Uber acquired Otto in August 2016, and since that time, I have been responsible for the technical development of Uber's LiDAR sensors.

3. I have never worked for Google or Waymo. I have worked on LiDAR technology since May 2008. Prior to joining Otto, I was the Director of Engineering and co-founding member at Tyto from September 2012 to May 2016, when Tyto was acquired by Otto. Tyto specialized in designing and building LiDAR sensors for 3-D mapping. Prior to Tyto, I worked on developing LiDAR sensors at Velodyne Acoustics, Inc. ("Velodyne") from May 2008 to August 2012. Before working at Velodyne, I was a senior staff mechanical engineer at KLA-Tencor Corp., where I worked for over 12 years. I received my Bachelor of Science in mechanical engineering from the University of California, Berkeley in 1994.

4. I have never knowingly used any confidential or trade secret documents or information from Google or Waymo for the design or development of Otto's or Uber's LiDAR technologies. I was never directed by anyone at Uber to use any confidential Google or Waymo documents for the design or development of Otto's or Uber's LiDAR technologies. I have never seen any evidence of any confidential Google or Waymo documents or files being used during my employment at Otto and Uber.

Fuji Design

5. In late October 2016, my team started developing an in-house LiDAR solution that we code-named "Fuji" after Mount Fuji. During that time, I met with Scott Boehmke and Eric Meyhofer at Uber's Advanced Technologies Center in Pittsburgh, Pennsylvania. I understand that Scott and Eric had joined Uber in early 2015 along with approximately forty researchers, academics, and engineers from Carnegie Mellon University, Carnegie Robotics LLC, and the National Robotics Engineering Center (NREC). It is also my understanding that this is when Uber first began work on self-driving vehicles.

6. After in-person discussions, we decided that my team should build an in-house LiDAR solution using direct diode projections (i.e., laser diodes) with beam spacing and angles provided by Scott Boehmke. I understand that Scott developed the beam spacing and angles based on parameters and calculations similar to those he provided to [redacted], prior to Uber's acquisition of Otto. I was in charge of overseeing the LiDAR design based on the beam spacing and angles that Scott Boehmke, in Uber's Pittsburgh office, provided.

7. Figure 1, below, is a true and correct photo of Fuji as of March 2017. Fuji has two optical cavities, each with 32 channels oriented at different vertical angles to capture the field of view necessary for applications in self-driving vehicles. Each cavity has separate receive and transmit lenses. The cavity on the left (which I will refer to as the "medium-range cavity") is tilted downwards [redacted] in order to see the ground and any obstacles immediately in front of a vehicle. The cavity on the right (which I will refer to as the "long-range cavity") [redacted], allowing it to see obstacles up to the full detection range.

[redacted]

8. We decided to use two cavities in the Fuji design primarily because I wanted to use simple collimation lenses (i.e., the transmit lenses) for the optical transmit paths. A simple transmit lens design does not perform well when light passes through the lens at a steep angle relative to the axis through the center of the lens. To minimize interference within a cavity, the laser diodes are configured to fire one at a time. By using two cavities with 32 channels each, Fuji can fire two laser diodes simultaneously, with the diodes well separated vertically to minimize interference between the laser diodes.

9. Figures 2A and 2B, below, are true and correct annotated CAD drawings of a cross-sectional top view of a single optical cavity within Fuji. The "medium-range cavity" and "long-range cavity" use the same mechanical components and lenses. Figure 2A, below, shows a line drawing of one of the optical cavities, and Figure 2B, below, shows a colored version of one of the optical cavities, including the light paths (i.e., the red and blue regions). As evident from the CAD drawings, each cavity comprises two separate compartments—a narrower compartment for the transmit path and a wider compartment for the receive path. Annotated below is a metal separation that optically separates the transmit path and the receive path, so that within each cavity the transmit path and the receive path do not overlap. This metal separation prevents

interference between the emitted light and the target-reflected light within the receive compartment. Care is taken to ensure that the light emitted from the transmit path does not enter the receive path until after it exits the transmit lens and is reflected from a target. Moreover, the transmit path has a separate lens from the receive path. The narrower lens is for the transmit path, and the wider lens is for the receive path. In designing the lens for the transmit path, there is no benefit to making the transmit lens significantly larger than the footprint of the light projected by the laser diodes. For the receive lens, a larger receive lens is desirable to capture more of the target-reflected light, thus improving the sensor's ability to detect and range darker objects at farther distances.

[redacted]

10. Each cavity in Fuji has 32 channels, and each channel represents light from a single laser diode. Fuji uses [redacted] laser diodes, which emit light with a wavelength of approximately 905 nm. A laser diode such as the [redacted] has a large divergence angle in one direction (i.e., in the fast axis, as shown in Figure 3 below[1]). As a result, depending on its distance from the main collimation lens (e.g., a transmit lens), the light emitted by the diode may spread too much before it reaches the main collimation lens. Thus, as well known in the art, the laser diode cannot be efficiently used unless it is pre-collimated with a fast axis collimating ("FAC") lens that focuses and redirects the light towards the transmit lens.[2]

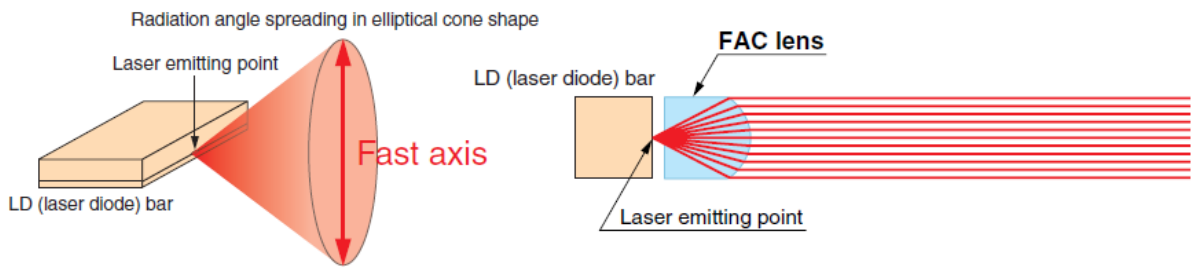

Figure 3

11. The 32 laser diodes in each cavity are distributed across [redacted]. I came up with the idea of distributing the 32 laser diodes across [redacted] through an iterative approach. [redacted]. Exhibit A attached hereto is a true and accurate copy of an email exchange I had with Scott Boehmke on October 28, 2016 (discussing potentially [redacted] and separate lenses for transmit and receive). We ultimately decided to use [redacted] because distributing 32 laser diodes on [redacted] allowed for a minimum of [redacted] spacing between adjacent laser diodes, which we determined provided

[1] *See* Hamamatsu, *FAC Lens (Fast-Axis Collimating Lens) J10919 Series, available at* https://www.hamamatsu.com/resources/pdf/etd/J10919_TOTH1005E.pdf.
[2] *See id.*

sufficient space for the firing circuit and the FAC lens. We further decided to put [redacted].

12. The transmit PCBs within the transmit compartment are arranged with their edges facing the transmit lens because [redacted] diodes are edge-emitting laser diodes, i.e., light is emitted from an edge, such as seen above in Figure 3. The [redacted] within a transmit block are mounted onto the transmit block using [redacted]. The spacing between the [redacted] is constrained by the spacing between the columns of detectors on the receive board, because the spacing on the detectors is more restrictive due to the need to fit 32 detectors and circuity on a single receive board.

13. Figure 4, below, is a true and correct annotated CAD drawing of a cross-sectional top view of the Fuji design. In the "long-range cavity" (which is the cavity on the left), the 32 diodes are distributed as follows: [redacted] [redacted]. In the "medium range cavity" (which is the cavity on the right), the 32 laser diodes are distributed as follows: [redacted]. In other words, the order of the boards from left to right, across the two cavities, is as follows: [redacted]:

[redacted]

14. There are two fiducials on each transmit PCB. Fiducials are small reference marks that are printed on a PCB for automated alignment. Uber uses the fiducials to position the individual laser diodes on a PCB, where the bottom fiducial represents the origin of an x-y coordinate system, and the upper fiducial is used to indicate the orientation of the x-y coordinate system. This is a common and well-known technique in the fabrication of a PCB for precise positioning of components.[3] There are also [redacted]

[3] *See, e.g.*, Optimum Design Associates, *Are Local Fiducials Necessary?*, http://blog.optimumdesign.com/are-local-fiducials-necessary; Worthington Assembly, *Working*

[redacted]. This is a common technique for aligning mechanical components based on my experience as a mechanical engineer.[4] Figures 5A and 5B, below, illustrate a transmit PCB A. Figure 5A is a true and correct CAD drawing of a transmit PCB A. Figure 5B is a true and correct photo of a transmit PCB A. In Figure 5B, I have circled in green the fiducials on the PCB.

[redacted]

15. Figures 6A-F, below, show true and correct CAD drawings of transmit PCBs A-C in the "medium-range cavity" and transmit PCBs D-F in the "long-range cavity." Exhibit B attached hereto is a true and correct copy of the specific position and orientation of each diode on transmit PCBs A-F. Transmit PCBs A-C in the "medium-range cavity" have a field of view (FOV) from [redacted], for a total FOV of [redacted]. Transmit PCBs D-F in the "long-range cavity" have a FOV from [redacted], for a total field of

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with a Manufacturer – What are Fiducials and why are they Useful? (Apr. 17, 2015), https://www.worthingtonassembly.com/blog/2014/12/29/what-are-fiducials-and-why-are-they-useful.

[4] *See, e.g.*, MiSUMi USA, *Principles of Positioning*, https://us.misumi-ec.com/maker/misumi/mech/tech/locating_pins_tutorial/.

view of [redacted]. Because the "long-range cavity" [redacted] and is intended to see obstacles up to the full detection range, the laser diodes are tightly positioned on transmit PCBs D-F such that there is uniform angular spacing between laser diodes of approximately 0.39 degrees.

[redacted]

16. The firing of a light pulse from each laser diode in Fuji is controlled using a laser diode firing circuit. Exhibits C and D attached hereto illustrate ten laser firing circuit designs

considered for Fuji. None of the circuit designs includes the use of an inductor, which complicates the circuitry and takes up more space on the PCB.

17. Each cavity also includes a filter and [redacted] in the receive compartment. The filter blocks out light in the receive path that is not near 905 nm (i.e., the wavelength of the emitted light), effectively preventing noise, such as sunlight, from reaching the detectors. [redacted] a flat receive PCB. Figure 8 is a true and correct annotated CAD drawing of a cross-sectional top view of a single optical cavity within Fuji, showing the filter and [redacted] the flat receive PCB.

[redacted]

18. The position and orientation of the laser diodes in Fuji is based on the beam patterns and parameters provided by Scott Boehmke and his team in Pittsburgh, Pennsylvania. Exhibit E attached hereto is a true and correct copy of the custom beam spacing and angle summary Scott provided on November 4, 2016, which includes the required beam angles for a 64 channel LiDAR with two cavities, on a vehicle traveling at 30 mph, 35 mph, 40 mph, and 45 mph. The current Fuji design is based on the beam angles for a vehicle traveling up to approximately 35mph. My team imported the data in this summary into Zemax (ray tracing simulation) software to determine the resultant emitting points of the laser diodes. This data was

then exported into SolidWorks CAD software as the basis for the initial optical cavity designs and transmit PCB designs.

19. Anthony Levandowski has never had, nor currently has, any design input in the number of boards, number of cavities, number of channels, beam parameters, or location and orientation of the laser diodes on the transmit PCBs. Nor have I ever seen any of the 14,000 documents allegedly downloaded by Anthony, or used any such documents in designing the Fuji LiDAR.

Fuji Development Timeline and Efforts

20. There are approximately [redacted] employees currently working on the Fuji project. Since November 1, 2016, the first full month of Uber's work on Fuji, until March 31, 2016, Uber has spent many thousands of hours on developing Fuji.

21. To date, no Fuji sensor has ever been mounted on any vehicle for testing or any other purpose. All Uber cars currently on the road, for commercial use, testing, or any other purpose, use third-party sensors.

22. Uber will not be ready to deploy any public vehicles with Fuji sensors for self-driving purposes prior to [redacted]. In other words, Uber will not be ready to "commercialize" or "launch" any vehicles using the Fuji sensor for self-driving purposes prior to that time.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed this on 7th day of April, 2017, in San Francisco, California.

/s/ James Haslim
James Haslim

ATTESTATION OF E-FILED SIGNATURE

I, Arturo J. González, am the ECF User whose ID and password are being used to file this Declaration. In compliance with General Order 45, X.B., I hereby attest that James Haslim has concurred in this filing.

Dated: April 7, 2017

/s/ Arturo J. González
Arturo J. González